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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

In the Matter of)

)
)
Replacement of Part 90 by Part 88 to)
Revise the Private Land Mobile Radio)
Services and Modify the Policies)
Governing Them)

PR Docket No. 92-235

To: The Commission

COMMENTS OF
NIPPON TELEGRAPH AND TELEPHONE CORPORATION

Nippon Telegraph and Telephone Corporation ("NTT"), by its attorneys, hereby submits its comments in response to the Notice of Proposed Rulemaking, 7 FCC Rcd 8105 (1992) ("NPRM"), issued in the above-captioned proceeding on November 6, 1992. NTT commends the Commission for its effort to reduce frequency congestion in the spectrum below 512 MHz and to move the private land mobile radio services ("PLMRS") toward more orderly and efficient use of this limited resource.

I. INTRODUCTION.

In the Notice of Inquiry 6 FCC Rcd. 4126 (1991) ("NOI"), in PR Docket No. 91-170, the proceeding that led up to the instant rulemaking, the Commission acknowledged that the PLMRS spectrum has become congested to a point that: (1) threatens the ability of public safety organizations to carry out their mission; and (2) materially affects the productivity of businesses and industries that rely on those radio services. See id. at 4126. The National Telecommunications and Information

the NTIA for federal government users and by the FCC for all other users -- are under increasing strain as the demand for existing spectrum-based services grows."^{1/}

In these comments, NTT will provide detailed information regarding a new technology it has developed called RZ SSB (acronym for "Real Zero Single Side-Band"). Extensive laboratory tests and field trials have demonstrated that this

- Timing. Assuming an appropriate regulatory climate, RZ SSB-based equipment can be available in the U.S. market within the next two or three years.

The above-referenced technical features are discussed in greater detail in the attached Technical Appendix.

The existence of this readily available, cost-effective technology should permit the Commission expeditiously to implement an efficient channel spacing scheme, without fear of causing significant disruptions in the PLMRS. As is described in greater detail below and in the Technical Appendix, RZ SSB technology, which combines high-quality information-carrying capability and 5 kHz channelization, is available to meet the FCC's stated channel spacing goals.


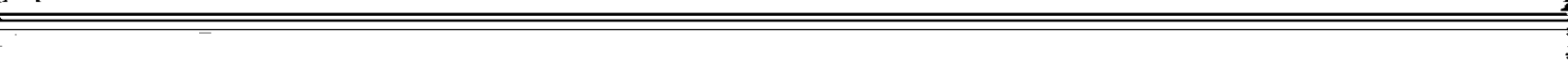
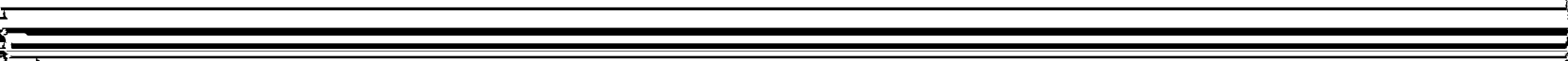









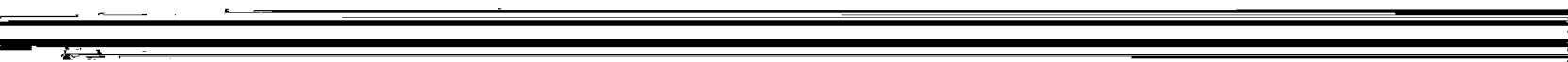


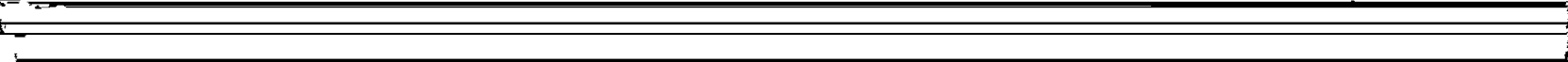
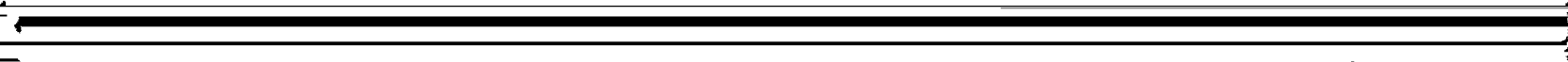

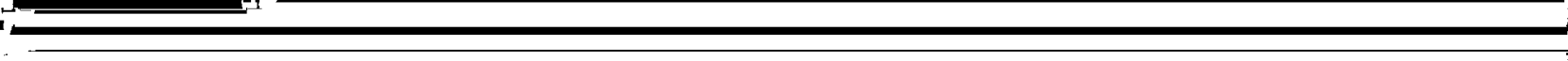

II. NTT'S INTEREST IN THIS PROCEEDING.

NTT was founded as Nippon Telegraph and Telephone Public Corporation in 1952 by the Japanese government. It was privatized in April 1985, entering the private sector as Nippon Telegraph and Telephone Corporation. NTT is the largest telecommunication services provider in Japan. While NTT does not engage in manufacturing, its corporate philosophy gives high priority to the pursuit of research and development ("R&D") activities at a global level. Presently, its research efforts are focused on two key areas: advanced networking, and the development of new communications technologies. With regard to the latter, considerable emphasis is placed on mobile services.

In the mobile service area, a primary concern for NTT in developing new technologies is spectrum efficiency. For

example, in 1983, NTT was the first in the world to introduce narrow-band (12.5 kHz channel spacing) FM for the Japanese cellular telephone system. Another example is NTT's development of GMSK (acronym for "Gaussian-filtered Minimum Shift Keying") technology, which is currently used in European digital cellular systems.

NTT began its research on RZ SSB technology in 1984, shortly after the introduction of its narrow-band FM cellular technology. The company's goal was to develop the next generation narrow-band technology for the Japanese market. After



Radio Bureau's ("PRB") "Refarming Roundtable" meeting, held on May 6, 1993, to present a discussion of RZ SSB technology.^{3/}

NTT is convinced that RZ SSB is capable of providing an optimal solution to many of the spectrum efficiency concerns under consideration in this proceeding. Although, as noted above, NTT is not a manufacturer, it can be asserted with confidence that RZ SSB-based equipment can be available in the U.S. marketplace within the next two or three years, e.g., through the granting of licenses to domestic and foreign companies interested in manufacturing such products. It is from this perspective that NTT submits its comments on the Commission's "refarming" proposals.

III. THE COMMISSION MUST CONTINUE IN
ITS EFFORT TO ENSURE THE EFFICIENT
USE OF THE SPECTRUM BY THE PLMRS.

A. General Public Interest Considerations.

Reliance on spectrum-based technologies is critical to the continued evolution of the domestic and international telecommunications infrastructure. Spectrum management has become increasingly difficult, as the demand for spectrum-dependent communications technologies and services continues to grow at a rapid rate. In the PLMRS, the demand for spectrum long ago began to outstrip supply. The ever-increasing proliferation of mobile services has led to acute spectrum congestion and

^{3/} During that same time frame, Dr. Daikoku met with representatives of NTIA, various user groups, and standards-setting organizations regarding RZ SSB technology.

interference on many, if not most, PLMRS channels, including those dedicated to public safety functions.

NTT applauds the Commission's attempt to combat the problem of frequency congestion by adopting a bold new regulatory structure specifically designed to increase the efficiency with which the PLMRS uses the spectrum. In order to succeed in this effort, NTT believes that the Commission should adopt a three-part approach to the problem. First, it should provide incentives within the channel licensing process sufficient that each licensee will deem it to be in its interest to maximize its efforts to achieve increased spectrum efficiency. Second, and of equal (if not greater) importance, the Commission should establish basic performance criteria to ensure that at least threshold efficiency standards will be met. Finally, the Commission should expedite the transition to narrow-band technology, while still taking into consideration both the legitimate need of users to amortize fully their existing equipment and the fact that an orderly transition is essential to the overall success of the Commission's efforts.

Regarding the first point, NTT has no view on the specific merits of either the exclusive-use-overlay concept or any other licensing-based incentives, other than to note that some incentives should be built into the licensing process. Below, NTT will focus its attention on the latter two elements of a successful regulatory scheme.

B. Channel Spacing Should Be Reduced To
5 kHz For All Frequencies Below 512 MHz.

The Commission has proposed to reduce channel spacing to 5 kHz for low power mobile frequencies in the 72-76 MHz band and for all frequencies in the 150-174 MHz band. In the 421-430 MHz, 450-470 MHz, and 470-512 MHz bands, a reduction in channel spacing to 6.25 kHz has been proposed. As is demonstrated below, there is no valid technical or economic reason for not adopting a 5 kHz channelization plan for all of the affected frequency bands.

NTT has conducted a wide range of tests with RZ SSB transmission technology and has demonstrated that 5 kHz channel spacing -- with an information signal bandwidth ranging from 300 Hz to 3.4 kHz -- is now technologically feasible and economically practical. See Technical Appendix passim. Given the magnitude of spectrum congestion in the PLMRS environment, the move to 6.25 kHz channel spacing in the 421-512 MHz band appears unnecessarily wasteful of radio spectrum. Indeed, as is demonstrated below, the near-term availability of the RZ SSB system undermines the main assumption relied on in the NPRM as a basis for adopting a 6.25 kHz standard for the bands above 421 MHz.

C. The Transition Period For The Move To
5 kHz Channel Spacing Should Be Accelerated
And Should Not Include Two-step Channel Splitting.

The Commission has proposed a two-step procedure for reducing bandwidths of various channels, with target dates ranging from 2004 to 2012. In the interim period, certain existing users would be required temporarily to employ "pseudo-

12.5 kHz equipment," before transitioning to a "final" narrow-band technology. See NPRM, App. A, at 13-14. The only apparent reason for adopting this two-step plan is the assumption that the interim step is needed to provide adequate time for the development of that final narrow-band technology.

If this assumption is correct, then there is logic to moving first from 25 kHz channels to 12.5 kHz, and then from 12.5 kHz to 6.25 kHz channels. However, if, in reality, there is no technical or financial reason to insert that interim step, then the logic of both the interim step and the 6.25 kHz channels vanishes. If 5 kHz technologies are available in the near term, then a one-step transition from 25 kHz channels to 5 kHz channels is rational, economic, and far more spectrum-efficient.

While the PRB's May 6 Refarming Roundtable highlighted the different approaches to this issue being taken by various manufacturers, it also demonstrated that a variety of 5 kHz technologies will be entering the marketplace well before the Commission's proposed transition to 12.5 kHz spacing is scheduled to begin. In addition to RZ SSB, it appears that SEA, II Morrow, Uniden and Securicor all are poised to introduce some sort of 5 kHz-based system. Given the near-term availability of affordable narrow-band technologies, NTT believes that an accelerated transition period is both technologically and economically practical, and that the Commission may dispense with a cumbersome and unnecessary two-step procedure. NTT submits that it would be well within the realm of practicality to mandate universal 5 kHz channelization in all PLMRS frequencies below

512 MHz, within a time frame that permits current spectrum users to amortize their existing equipment, but does not require that they meet an unnecessary interim step.

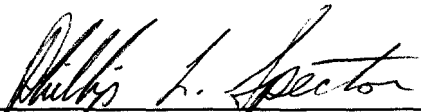
CONCLUSION

The Commission should promote spectrum use that is at least as efficient as existing technology permits. Prudence dictates that new regulations must allow for timely retirement of embedded equipment. Nevertheless, the timetable for implementing channel-splitting regulations and the level of spectrum efficiency required should be formulated in light of the fact that there are no serious technological or fiscal obstacles to the adoption of an across-the-board 5 kHz channelization plan. Narrow-band technology, such as the RZ SSB system, is presently available and capable of meeting or surpassing the Commission's spectrum efficiency goals on a commercially-viable basis.

Based on the foregoing, NTT urges the Commission to adopt a new regulatory structure for the PLMRS that incorporates the points discussed above.

Respectfully submitted,

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May 28, 1993

TECHNICAL APPENDIX

This technical appendix provides an overview of the RZ SSB (acronym for "Real Zero Single Side-Band") technology developed by Nippon Telegraph and Telephone Corporation ("NTT"). It also summarizes the experimental results of field testing of the RZ SSB system which NTT has conducted in the metropolitan area of Tokyo, Japan, a mobile radio environment that presents many of the same spectrum congestion problems and spectrum efficiency challenges confronting PLMRS licensees in U.S. metropolitan areas.

RZ SSB is a product of NTT's continuing efforts to develop spectrum-efficient mobile technologies. Work on the RZ SSB project began in 1984, shortly after the introduction of narrow-band FM into the cellular telephone system in Japan. FM information bandwidth is restricted by regulation to a maximum of 3 kHz, which is 400 Hz narrower than is permitted for telephone signals. Within this regulatory framework, it is difficult for an FM system to carry signals such as G3 facsimile at 9.6 kbps.

The goal of NTT's RZ SSB research was to develop a narrow-band system capable of a seamless interface with the telephone network. Therefore, NTT researchers started with the premise that the frequency bandwidth of the information signal must range from 300 Hz to 3.4 kHz, because the

interface between the mobile and landline systems must be transparent for a diverse array of signals.

Given the bandwidth constraints within which the researchers had to work, a Single Side-Band ("SSB") method was initially chosen, in order to fit the modulated signal into 5 kHz channel spacing. A conventional SSB transceiver must be equipped with Automatic Gain Control ("AGC") and Automatic Frequency Control ("AFC") circuits in order to combat fading. However, AGC and AFC circuits do not work well in fading environments. To date, only modest results have been achieved by those researchers who have attempted to improve the performance of AGC and AFC circuits.

system in which extraction of an information signal from the zero crossings is easy and practical. It is worth noting in this regard that the band-pass signal described in Mr. Logan's 1977 paper is identical to the RZ SSB signal.

The RZ SSB technology employs a combination of two established technologies: SSB signal transmission and phase modulation reception. The former maintains the narrow-band characteristics of the modulated signal and the latter provides immunity against fading and interference. Because RZ SSB is a waveform-preserved system, it can transparently carry digital signals, as well as analog signals transmitted in a single-channel-per-carrier format, even in a fading environment. Transmission performance is superior to that of conventional SSB systems.^{1/}

Shortly after NTT developed RZ SSB in the laboratory, a working group within the Ministry of Posts and Telecommunications ("MPT") asked NTT to conduct field tests of the RZ SSB technology. In February 1991, NTT began an extensive series of tests in the Tokyo metropolitan area, using channels in the 150 MHz band. A three-element Yagi antenna, located at a height of approximately 300 feet, and a specially equipped van were employed.

Various types of RZ SSB signals were tested -- including speech, voice-band MODEM, and G3 facsimile signals

^{1/} RZ SSB's features are summarized in Table I attached to this Appendix.

-- all operating within a 5 kHz channel spacing. Parallel tests were conducted using a narrow-band (12.5 kHz) FM transceiver (for cellular telephone). also operating in the

conventional cellular systems for facsimile. Based on these tests, the independent MPT working group concluded in March 1992 that the RZ SSB represents the best available narrow-band technology for operating in the VHF spectrum.

In addition to these field tests, extensive indoor experimental work has been conducted, including voice-band MODEM transmission at over 9.6 kbps. In these tests, Rayleigh fading simulators were used to simulate the mobile radio environment. This experiment revealed that the RZ SSB technology is transparent up to 19.2 kbps MODEM signal transmission, even in fading environments. Therefore, the maximum spectrum efficiency for RZ SSB is $19.2 \text{ kbps} / 5 \text{ kHz} = 3.84 \text{ bits/Hz.}^{6/}$

When a 5.6 kbps voice CODEC (which is currently

NTT is now conducting field testing for interference characteristics in the Tokyo metropolitan area. NTT has fabricated various analogue Large Scale Integrated ("LSI") circuits for the RZ SSB system, in order to reduce transceiver size and power consumption. While the use of LSI circuits with analogue systems has generally proven to be difficult, this has not proven to be the case for RZ SSB.

In conclusion, operating with 5 kHz channels, RZ SSB can handle a wide array of voice and data signals, providing high quality mobile communication and a seamless interface with the telephone network.

TABLE I
FEATURES OF RZ SSB TECHNOLOGY

ITEMS		FEATURES
1.	CHANNEL SPACING	5 kHz
2.	INFORMATION SIGNAL BANDWIDTH	300 Hz ~ 3.4 kHz
3.	VARIOUS TRANSMITTABLE SIGNALS	VOICE/ENCRYPTED VOICE G3 FACSIMILE VOICE-BAND MODEM
4.	MAXIMUM SPEED HANDLING CAPABILITY OF G3 FACSIMILE	9.6 kbps
5.	MAXIMUM DATA HANDLING CAPABILITY (TESTED)	19.2 kbps
6.	MAXIMUM SPECTRUM EFFICIENCY (DIGITAL)	3.48 bits/Hz (=19.2 kbps/5.0 kHz)
7.	VERSATILE CHANNEL USAGE	FDMA(SCPC)/TDD/TDMA
8.	ANALOG VOICE QUALITY	SUPERIOR TO 12.5 kHz FM
9.	DIGITAL VOICE QUALITY	5.6 ~ 8.0 kbps/CODEC
10.	DEGRADATIONS DUE TO MISTUNED CARRIER	NONE
11.	IMMUNITY TO FADING AND INTERFERENCE	STRONG
12.	COST COMPARED TO EXISTING EQUIPMENT	SAME

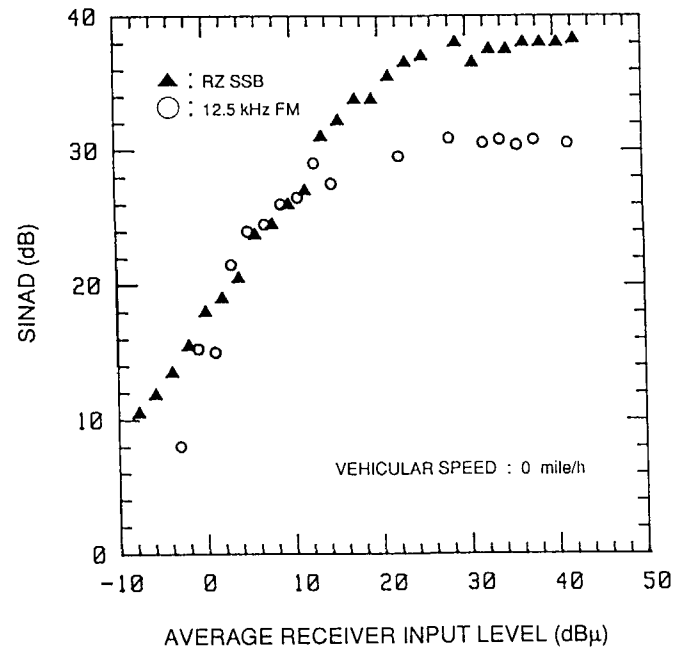


FIG. 1 FIELD TEST RESULTS FOR 1 kHz TONE SIGNAL.

A 1 kHz tone signal was appraised, as a function of average receiver input levels, by SINAD values using a dynamic SINAD processor. Although the speed of the van used for measurement was 0 miles per hour, vehicles around the van were moving. The RZ SSB and 12.5 kHz FM receiver were the same in noise figure values. Since the 12.5 kHz FM transmitter and receiver were originally fabricated for the Japanese cellular telephone system, their RF frequency was converted from 800 MHz to 150 MHz band. Experimental results for RZ SSB (▲) are superior to 12.5 FM (○) especially in the lower input levels.

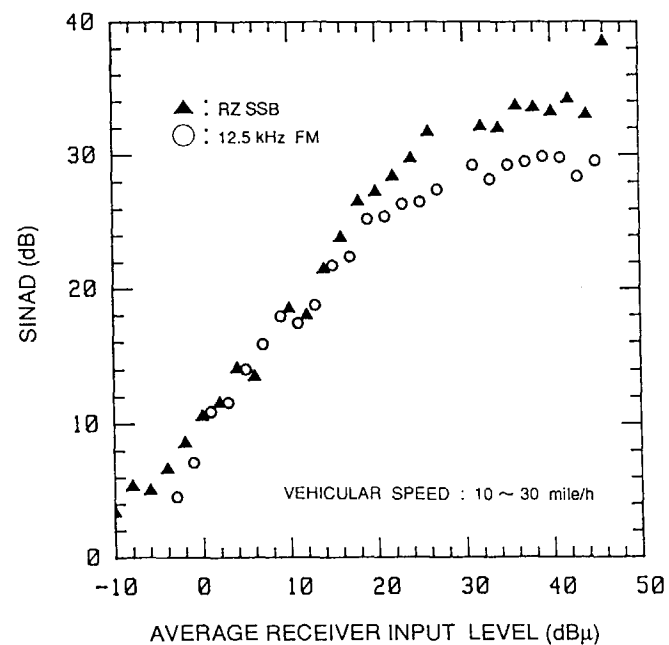


FIG. 2 FIELD TEST RESULTS FOR 1 kHz TONE SIGNAL WITHOUT INTRODUCTION OF TWO-BRANCH DIVERSITY RECEPTION METHOD.

A 1 kHz tone signal was appraised, as a function of average receiver input levels, by SINAD values. The speed of the van used for measurement ranged from 10 to 30 miles per hour. In this case, a diversity reception method was not introduced into both receivers. Experimental results for RZ SSB (▲) are considerably superior to 12.5 kHz FM (○).

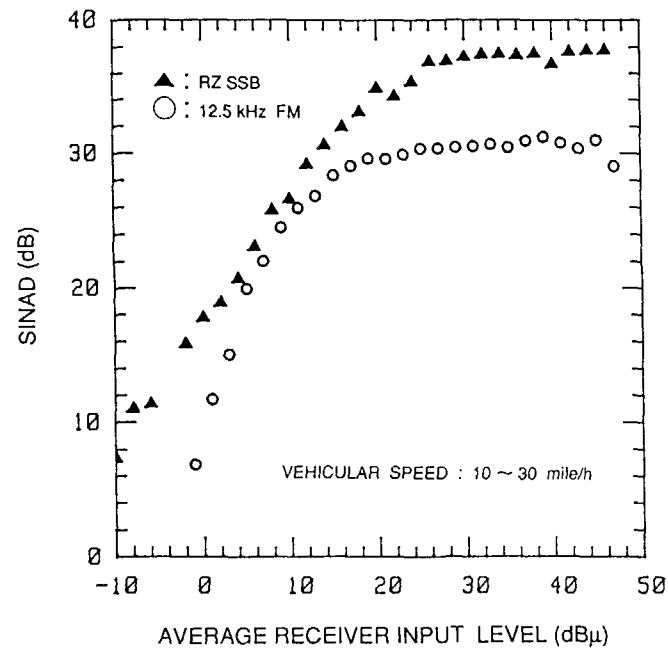


FIG. 3 FIELD TEST RESULTS FOR 1 kHz TONE SIGNAL FOLLOWING INTRODUCTION OF TWO-BRANCH DIVERSITY RECEPTION METHOD.

A 1 kHz tone signal was appraised, as a function of average receiver input levels, by SINAD values. The speed of the van used for measurement ranged from 10 to 30 miles per hour. The RZ SSB receiver was equipped with a two-branch equal-gain combining diversity technique, and the 12.5 kHz FM receiver was also equipped with a two-branch selective combining diversity technique. Experimental results for RZ SSB (▲) are superior to 12.5 FM (○) in the entire region.

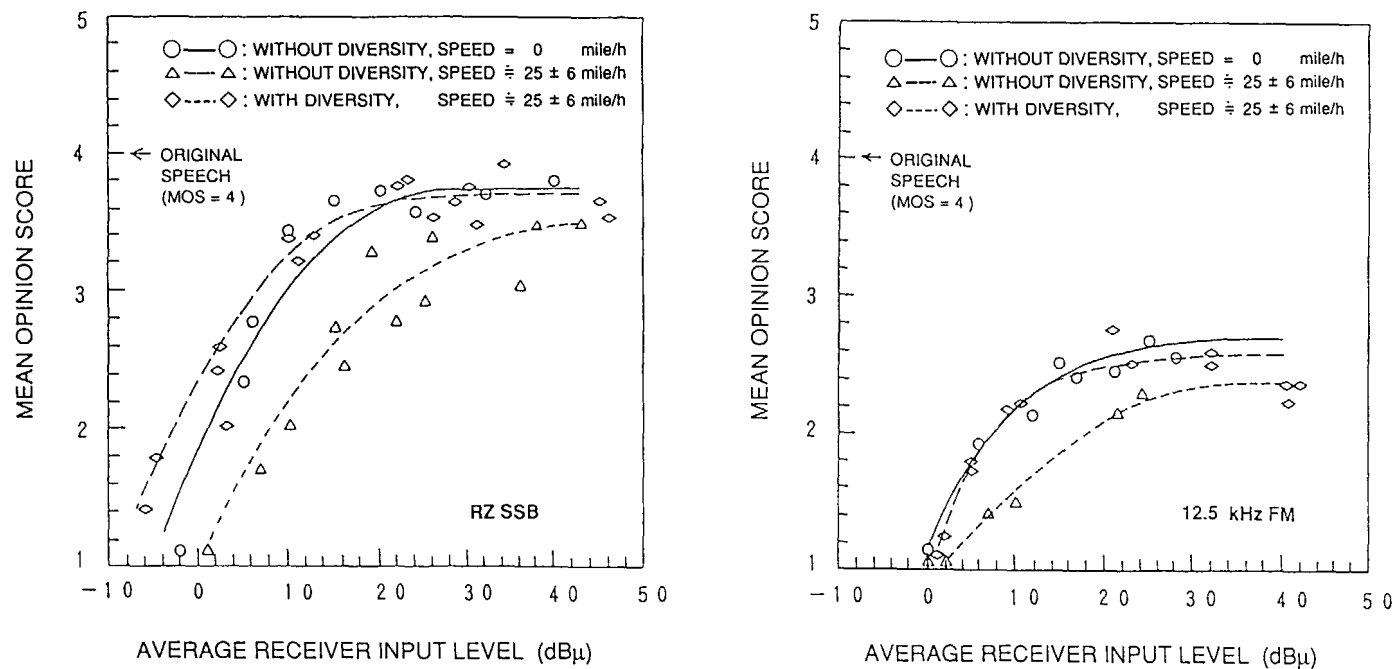


FIG. 4 FIELD TEST RESULTS FOR SHORT SPEECH SENTENCE APPRAISED BY MOS VALUES.

A short speech sentence (in Japanese) was appraised, as a function of average receiver input levels, by MOS (mean opinion score) values. The MOS test was conducted among approximately 20 people whose occupations are unrelated to mobile radio communications. In this test, the original speech quality was appraised as MOS = 4.0. MOS values for RZ SSB, shown on the left-hand side of the figure are superior to 12.5 kHz FM, shown on the right-hand side of the figure.

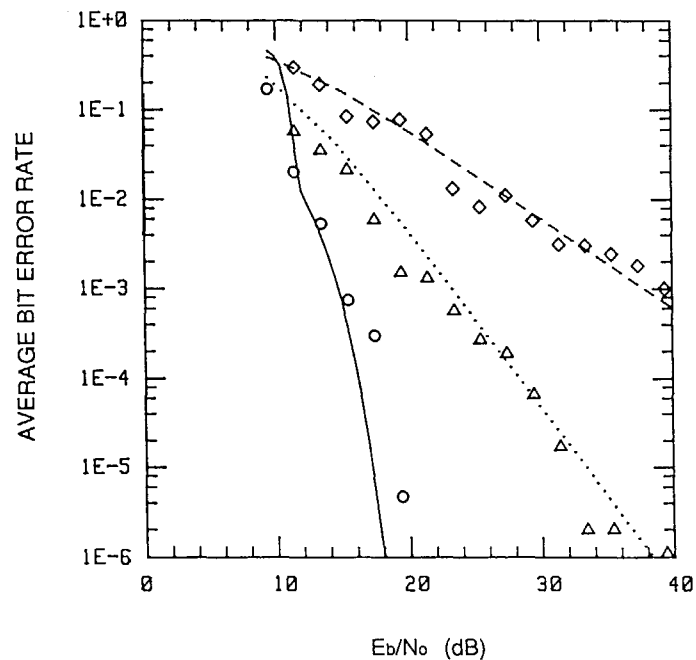


FIG. 5 FIELD TEST RESULTS FOR VOICE-BAND MODEM SIGNAL AT 9.6 kbps.

A 9.6 kbps voice-band MODEM signal with 16 QAM was appraised, as a function of E_b/N_0 , by bit error rates (BERs). The RZ SSB receiver was equipped with a two-branch equal-gain combining diversity circuit. Circles (○) denote the experimental results measured at 0 miles per hour vehicular speed. Triangles (△) and diamonds (◇) represent the experimental results using the receiver with and without diversity, respectively. During measurements, vehicular speed ranged from 10 to 30 miles per hour. The solid line (—) denotes the optimal fit curve for the indoor experimental data measured under thermal noise condition. The dotted (.....) and broken (---) lines are theoretically estimated curves for diversity and non-diversity, respectively. Experimental results agree well with the theoretical curves.

THE SLEREXE COMPANY LIMITED

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Our Ref. 350/PJC/EAC

18th January, 1972.

Dr. P.N. Cundall,
Mining Surveys Ltd.,
Holroyd Road,
Reading,
Berks.

Dear Pete,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

Phil.

P.J. CROSS
Group Leader - Facsimile Research

Registered in England: No. 2038
Registered Office: 60 Vicars Lane, Ilford, Essex.

FIG. 6 FIELD TEST RESULTS FOR 9.6 kbps G3 FACSIMILE SIGNAL.

The RZ SSB receiver equipped with a two-branch equal-gain combining diversity circuit was introduced in this test. Average receiver input levels were in the vicinity of 15 dB μ or larger than 15 dB μ , where BERs less than 10^{-4} can be obtained for the 9.6 kbps digital signal. The 9.6 kbps G3 facsimile signal was received when the vehicular speed was between 25 and 30 miles per hour. The above copy is 70 percent of the size of the originally transmitted (normal mode) facsimile.

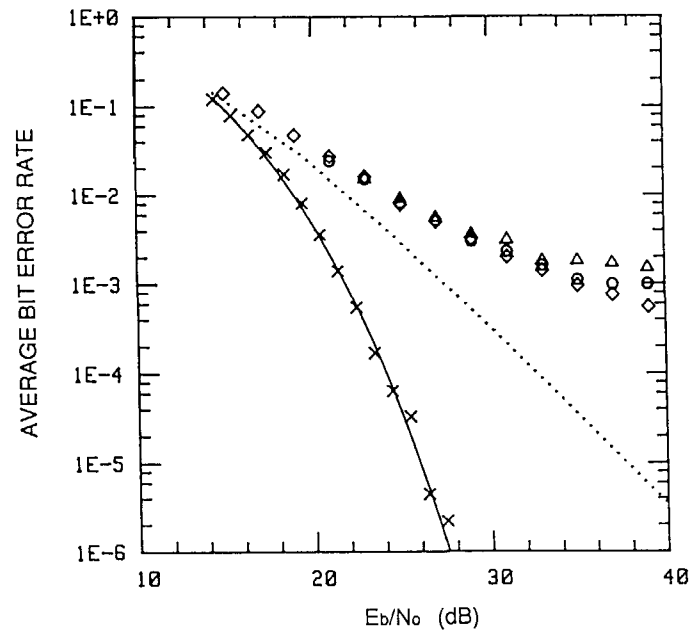


FIG. 7 INDOOR TEST RESULTS FOR 19.2 kbps VOICE-BAND MODEM SIGNAL.

A 19.2 kbps voice-band MODEM signal with 128 QAM was appraised, as a function of E_b/N_0 , by bit error rates (BERs). The RZ SSB receiver was equipped with a two-branch equal-gain combining diversity circuit. BERs were measured using both RF attenuators and Rayleigh fading simulators to simulate mobile radio environments. Crosses (×) denote the experimental results measured under the thermal noise. Diamonds (◇), circles (○), and triangles (△) represent the experimental results measured under fading frequencies of 5 Hz, 10 Hz, and 20 Hz, respectively. The solid line (—) denotes the optimal fit curve for the experimental data measured under thermal noise condition. The dotted line (.....) is theoretically estimated curve for diversity.